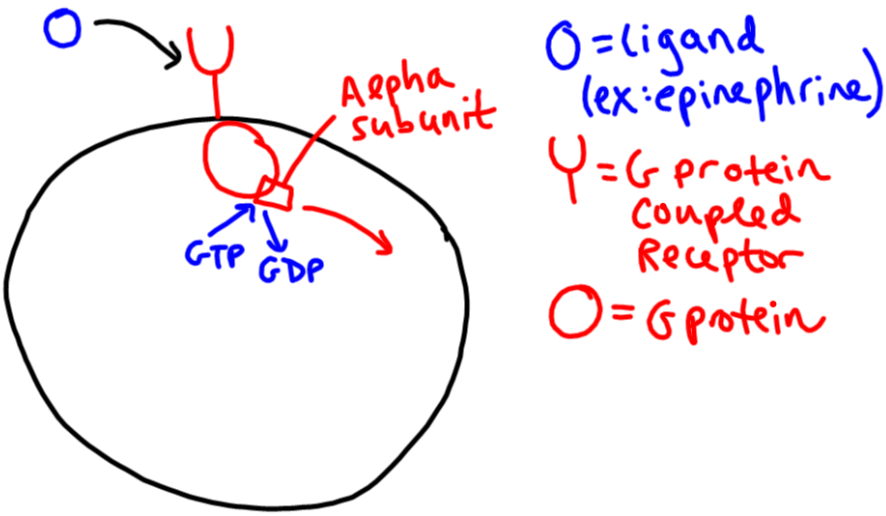
Signaling Pathway that includes a ligand, G-protein coupled receptor, cAMP as a second messenger, and protein kinases

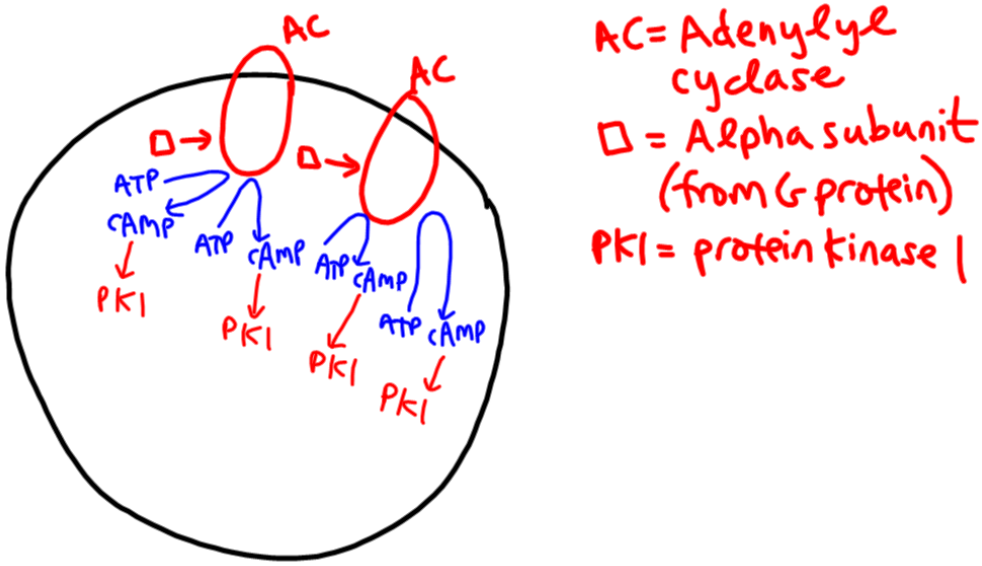
Step 1



What's happening? - The ligand binds to the G-protein coupled receptor, which activates the receptor by causing a shape change in the receptor. The activated receptor can then replace GDP with GTP on its associated G protein. This activates the G protein and causes a portion of the G protein (the alpha subunit) to pop off and travel throughout the cell.

How is the signal amplified at this step? - Several G proteins can be activated by one G-protein coupled receptor (by replacing GDP with GTP) in response to the binding of one ligand molecule.

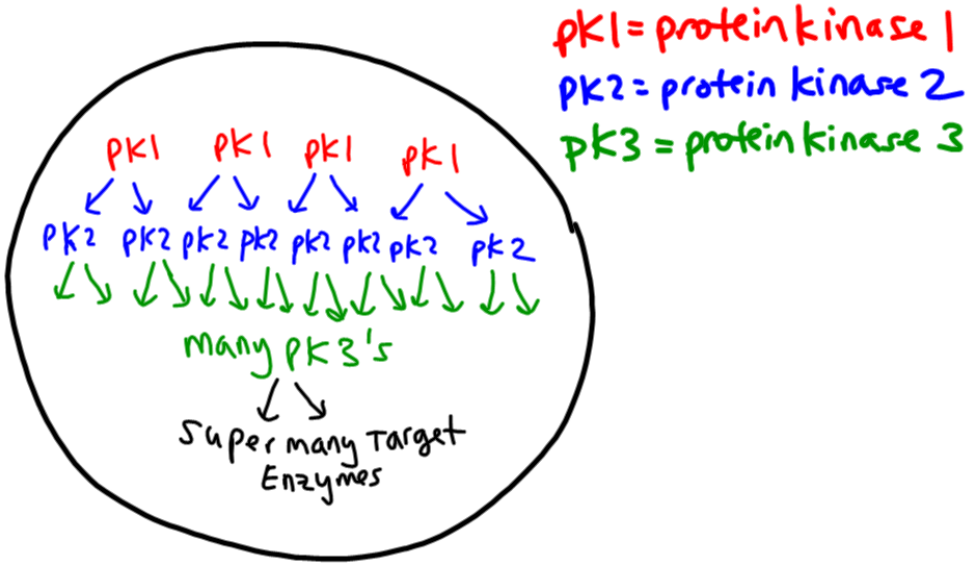
Step 2



What's happening? - Multiple activated alpha subunits from Step 1 bind to adenylyl cyclase proteins on the cell membrane and activate them. Adenylyl cyclase molecules then convert ATP to cyclic AMP (cAMP). cAMP molecules are then able to activate protein kinase 1 molecules.

How is the signal amplified at this step? - Each active adenylyl cyclase can convert many ATP molecules to cAMP molecules.

Step 3



What's happening? - Each PK1 molecule activates many PK2 molecules by taking phosphate groups (Pi's) from many ATP molecules and giving them to many PK2 molecules. Each PK2 molecule can then activate many more PK3 molecules (again by using phosphate groups from ATP molecules). Activating a molecule by adding a phosphate group to it is called phosphorylation

How is the signal amplified at this step? - When each PK molecule activates many PK molecules at the next level (by phosphorylating them), this is a form of amplification called a phosphorylation cascade. Additionally, the signal is further amplified because each target enzyme (ex: phosphorylase) can be used multiple times to create desired products (ex: when phosphorylase breaks down glycogen into individual glucose molecules to release into the bloodstream).